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Declaration

I, Michihiko Matsuba, President of Fukuyama Sangyo Honyaku Center, Ltd., of 16-3, 2-chome, Nogami-cho, Fukuyama, Japan, do solemnly and sincerely declare that I understand well both the Japanese and English languages and that the attached document in English is a full and faithful translation, of the copy of Japanese Patent Application No. Hei-10-281004 filed on October 2, 1998.

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[Title of document]	Specification	1 copy
[Title of document]	Drawing	1 copy
[Title of document]	Abstract	1 copy
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[Title of the document] Specifications

[Title of the invention] Stereoscopic photographic surveying target

[Claim 1] A stereoscopic photographic surveying target comprising a first pillar-shaped member and a second pillar-shaped member which are coupled to each other, at least three reference point members fixed on the pillar-shaped members and positioned on the same plane, and a non-reflection member which is attached to and detached from the reference point members.

[Claim 2] The stereoscopic photographic surveying target as set forth in Claim 1, wherein the reference point members are columnar members having substantially the same diameter as the dimension of the width of the first and second pillar-shaped members, and the bottom side at one side is closely adhered to the first or second pillar-shaped members.

[Claim 3] The stereoscopic photographic surveying target as set forth in Claim 2, wherein said non-reflection member is a disk, and a circular hole having substantially the same diameter as the diameter of said reference point members at the center of said disk.

[Claim 4] The stereoscopic photographic surveying target as set forth in Claim 3, wherein a reflection sheet that increases

the reflection amount of light is adhered to the bottom side which is not adhered to said first and second pillar-shaped members of said reference point members, and a non-reflection sheet that decreases the reflection amount of light is adhered to the side of said non-reflection member, which is located on the same side as the side where the reflection sheet is provided.

[Claim 5] The stereoscopic photographic surveying target as set forth in Claim 4, wherein the reflection sheet of said reference point member and non-reflection sheet of said non-reflection members are provided on the same plane.

[Claim 6] The stereoscopic photographic surveying target as set forth in Claim 3, wherein a magnetic member is provided on one of said reference point members and said non-reflection member and a metallic member that is adsorbed to said magnetic member is provided on the other thereof.

[Claim 7] The stereoscopic photographic surveying target as set forth in Claim 6, wherein an annular magnet is provided at the peripheries of said reference point members and a metallic member is provided at the plane opposed to the side where said reflection sheet of said non-reflection member is provided, and at the periphery of said circular hole.

[Claim 8] The stereoscopic photographic surveying target as

set forth in Claim 6, comprising an inclination sensor for detecting inclination angles of horizontal planes around two orthogonal axes established on a reference plane that is determined by said reference point members; a direction sensor for detecting the directions thereof; and a transmission portion for wirelessly transmitting inclination angle data obtained from said inclination angle sensor and direction data obtained from said direction sensor.

[Claim 9] The stereoscopic photographic surveying target as set forth in Claim 8, wherein said non-reflection member is formed of a material capable of transmitting electric waves.

[Claim 10]The stereoscopic photographic surveying target as set forth in Claim 8, wherein said direction sensor is provided at an intermediate point between two prescribed reference point members adjacent to each other.

[Claim 11]The stereoscopic photographic surveying target as set forth in Claim 1, wherein said first and second pillar-shaped members are rotatbaly coupled to each other at respective end portions, vertically fixed when being used, and fixed substantially in parallel to each other when not being used.

[Claim 12]The stereoscopic photographic surveying target as set forth in Claim 1, comprising a fixing bar member for

vertically fixing said first and second pillar-shaped members when being used; a hinge for rotatably holding said fixing bar member on the first pillar-shaped member; and a lock hinge for detachably attaching said fixing bar member to said second pillar-shaped member.

[Claim 13]The stereoscopic photographic surveying target as set forth in Claim 12, comprising a first fixing mechanism for fixing said second pillar-shaped member on said first pillar-shaped member in parallel to each other when not being used; and a second fixing mechanism for fixing said fixing member on said first pillar-shaped member between said first pillar-shaped member and said second pillar-shaped member.

[Detailed description of the invention]

[0001]

[Technical field of the invention]

The present invention relates to a stereoscopic photographic surveying target that is used as reference scale in photography of a stereoscopic photographic survey.

[0002]

[Prior arts]

Conventionally, in photographic surveying that is carried out at a traffic accident site, an object is photographed at two points, using a still camera. Two-

dimensional coordinates of the subject are read from a picked-up image obtained from the photographing, and three-dimensional coordinates of the subject are obtained on the basis of the two-dimensional coordinates. A survey map of the traffic accident site is prepared from the three-dimensional coordinates of the subject.

[0003]

In such photographic surveying, a reference scale and a reference plane are required to prepare a survey map. Conventionally, in order to obtain such a reference scale and a reference plane, for example, three cone-shaped markers are installed at a photographing site. A plane determined by the tip ends of the three cone-shaped markers is determined to be a reference plane, and the distance between the reference points being the tip ends thereof are actually measured by a tape measure. The distance is made into a reference scale. However, installation of the cone-shaped markers and measurement of the distance between the reference points are carried out by persons, wherein there is a problem in that the procedure of photographing preparation is made cumbersome, and it takes much time.

[0004]

In order to solve such a problem, as shown in Japanese

Unexamined Patent Publication No. Hei-10-170263, such photographic surveying is disclosed, in which a photographic surveying target having a triangular frame member is installed at a photographing site instead of the three cone-shaped material members, and the distance between the reference point members secured on the three vertices of the frame members is made into a reference scale, and the plane determined by the three reference point members is made into a reference plane. The three reference point members are emphasized by adhering a reflection sheet, etc., and it is devised that the reference point members are easily identified on the picked-up image.

[0005]

[Objects to be solved by the invention]

However, if the pick-up conditions are worse, for example, in picking up at a site where the periphery is dark due to raining or at night, or at a site where the road surface is easily reflected, it becomes difficult to distinguish the reference point members in a picked-up image, and there is a fear of worsening accuracy in photographic surveying.

[0006]

The present invention was developed in view of these points, and it is therefore an object of the invention to easily identify the reference point members on a photographic

surveying target in a picked up image, and to improve accuracy of photographic surveying.

[0007]

[Means for solving the object]

A stereoscopic photographic surveying target according to the invention includes: a first pillar-shaped member and a second pillar-shaped member which are coupled to each other; at least three reference point members fixed on the pillar-shaped members and positioned on the same plane; and a non-reflection member which is attached to and detached from the reference point members.

[0008]

In the stereoscopic photographic surveying target, preferably, the reference point members are columnar members having substantially the same diameter as the dimension of the width of the first and second pillar-shaped members, and the bottom side at one side is closely adhered to the first or second pillar-shaped members. Further preferably, the non-reflection member is a disk, and a circular hole having substantially the same diameter as the diameter of the reference point members at the center of the disk.

[0009]

In the stereoscopic photographic surveying target, a

reflection sheet is adhered to the bottom side which is not adhered to the first and second pillar-shaped members of the reference point members, and a non-reflection sheet is adhered to the side of the non-reflection member, which is located on the same side as the side where the reflection sheet is provided. In this case, the reflection sheet of the reference point member and non-reflection sheet of the non-reflection member are provided on the same plane.

[0010]

In the stereoscopic photographic surveying target, preferably, a magnetic member is provided on one of the reference point members and the non-reflection member, and a metallic member that is adsorbed to the magnetic member is provided on the other thereof. Further preferably, an annular magnet is provided at the surrounding of the reference point members, and a metallic member is provided at the plane opposed to the side where the reflection sheet of the non-reflection member is provided, and at the surrounding of the circular hole.

[0011]

The stereoscopic photographic surveying target further includes: an inclination sensor for detecting inclination angles of horizontal planes around two orthogonal axes established on a reference plane that is determined by the

reference point members; a direction sensor for detecting the directions thereof; and a transmission portion for wirelessly transmitting inclination angle data obtained from the inclination angle sensor and direction data obtained from the direction sensor. In this case, the non-reflection member is formed of a material capable of transmitting electric waves, and the direction sensor is provided at an intermediate point between two prescribed reference point members adjacent to each other.

[0012]

In the stereoscopic photographic surveying target, preferably, the first and second pillar-shaped members are rotatbaly coupled to each other at respective end portions, vertically fixed when being used, and fixed substantially in parallel to each other when not being used.

[0013]

Further preferably, the stereoscopic photographic surveying target includes: a fixing bar member for vertically fixing the first and second pillar-shaped members when being used; a hinge for rotatably holding the fixing member on the first pillar-shaped member; and a lock hinge for detachably attaching the fixing bar member to the second pillar-shaped member. Still further preferably, the stereoscopic

photographic surveying target includes: a first fixing mechanism for fixing the second pillar-shaped member on the first pillar-shaped member in parallel to each other when not being used; and a second fixing mechanism for fixing the fixing bar member on the first pillar-shaped member between said first pillar-shaped member and the second pillar-shaped member.

[0014]

[Embodiments of the invention]

Hereinafter, a description is given of an embodiment of a stereoscopic photographic surveying target according to the invention with reference to the accompanying drawings. Prior to the description, a description is given of one example of stereoscopic photographic surveying using a stereoscopic photographic surveying target.

[0015]

Fig. 1 shows the relationship between a stereoscopic photographic surveying target 10, a cube 102 being a subject, and cameras 100. The cube 102 and target 10 are photographed at both the first camera position M_1 and second camera position M_2 by the cameras 100. The first camera position M_1 and second cameras position M_2 are defined to be the principal point position behind the photographing lens of the camera 100, wherein the first camera position M_1 is shown with a solid line

and the second camera position M_2 is shown with a broken line. The optical axis at the respective camera positions M_1 and M_2 are shown with one-dotted chain lines O_1 and O_2.

[0016]

The target 10 exhibits an L-shaped letter, to which two pillar-shaped members are connected. Although seven reference point members are provided on the target 10, only three reference point members which are the vertices are used for description in order to simplify complication of the drawings. The three vertices are determined to be reference point members P_1, P_2, and P_3. The plane determined by the reference point members P_1, P_2 and P_3 is made into a reference plane, and the distance between the reference point member P_1 and the reference point member P_2 is shown as a reference scale L. Also, the distance between the reference point members P_1 and P_2 is equal to the distance between the reference point members P_2 and P_3, wherein the angle formed by sides P_1P_2 and P_2P_3 is 90 degrees.

[0017]

An image picked up at the first camera position M_1, that is, the first image, is shown in Fig. 2(a), and an image picked up at the second camera position M_2, that is, the second image, is shown in Fig. 2(b). The first two-dimensional orthogonal coordinate system (x_1, y_1) is set for the first image, and the

coordinate origin point is determined at the photographing center c_1 of the first image. As has been made clear in Fig. 2(a), in the first image, image points of the reference point members P_1, P_2 and P_3 are, respectively, shown by coordinate values p_{11} (px_{11}, py_{11}), p_{12} (px_{12}, py_{12}), and p_{13} (px_{13}, py_{13}).

[0018]

The second two-dimensional orthogonal coordinate system (x_2, y_2) is set for the second image, and the coordinate origin point is determined at the photographing center c_2 of the second image. As has been made clear in Fig. 2(b), in the second image, image points at the reference point members P_1, P_2 and P_3 are, respectively, shown by coordinates p_{21} (px_{21}, py_{21}), p_{22} (px_{22}, py_{22}), and p_{23} (px_{23}, py_{23}).

[0019]

Respective coordinates of the reference point members P_1, P_2 and P_3 on the first and second images may be expressed as p_{ij} (px_{ij}, py_{ij}). Herein, a variable i indicates the number of images, and i=1 corresponds to the first image in Fig. 2(a), i=2 corresponds to the second image in Fig. 2(b). In addition, a variable j is coincident with the number of the reference point members P_j. In the present embodiment, j= 1, 2, and 3 is established.

[0020]

Fig. 3 shows the relative positional relationship between the first and second images and the target 10 when being photographed by the camera 100. At this time, the distance between the reference point member P_1 and reference point member P_2 on the target 10 is made into a relative length, which is shown by L'. Also, the reference planes determined by the reference point members P_1, P_2 and P_3 are shown by a hatched area in the drawing.

[0021]

Herein, in order to specify the three-dimensional position of the cube 102 on the basis of the first and second images, a three-dimensional orthogonal coordinate system (X, Y, Z) is appropriately established. In Fig. 3, the three-dimensional orthogonal coordinate system is the right-handed system, and the coordinate origin point is made coincident with the first camera position M_1, and the Z axis is made coincident with the optical axis O_1 at the first camera position M_1.

[0022]

At this time, the three-dimensional coordinate of the second camera position M_2 is shown by the three-dimensional coordinate (Xo, Yo, Zo), and the three-dimensional coordinate indicates the displacement amount of the second camera position M_2 with respect to the first camera position M_1. Further, the

three-dimensional angular coordinates of the optical axis O_2 at the second camera position M_2 are shown by (α, β, γ), and the three-dimensional angular coordinates indicate a rotation angle of the optical axis O_2 with respect to the optical axis O_1. That is, α shows an angle created by the optical axis O_2 and X axis of the three-dimensional orthogonal coordinate system, β shows an angle created by the optical axis O_2 and Y axis of the three-dimensional orthogonal coordinate system and γ shows an angle created by the optical axis O_2 and Z axis of the three-dimensional orthogonal coordinate system.

[0023]

Also, the three-dimensional coordinates of the three reference point members P_1, P_2 and P_3 at the three-dimensional orthogonal coordinate system (X, Y, Z) are expressed by P_1 (PX_1, PY_1, PZ_1), P_2 (PX_2, PY_2, PZ_2) and P_3 (PX_3, PY_3, PZ_3), and the three-dimensional coordinates may be expressed by P_j (PX_j, PY_j, PZ_j) (where j= 1, 2, 3).

[0024]

As has been made clear in Fig. 3, the respective reference point members P_j, image points p_{ij} on the first and second images, and first and second camera positions M_1 and M_2 are located on the same straight line. Therefore, the three-dimensional coordinates P_j (PX_j, PY_j, PZ_j) may be obtained by a collinear

equation shown in the following expression (1).

[0025]

[Expression 1]

$$PX_j = (PZ_j - Zo)\frac{a_{11}px_{ij} + a_{21}py_{ij} - a_{31}C}{a_{13}px_{ij} + a_{23}py_{ij} - a_{33}C} + Xo$$

$$PX_j = (PZ_j - Zo)\frac{a_{12}px_{ij} + a_{22}py_{ij} - a_{32}C}{a_{13}px_{ij} + a_{23}py_{ij} - a_{33}C} + Yo$$

however,

$a_{11} = \cos\beta \bullet \sin\gamma$

$a_{12} = -\cos\beta \bullet \sin\gamma$

$a_{13} = \sin\beta$

$a_{21} = \cos\alpha \bullet \sin\gamma + \sin\alpha \bullet \sin\beta \bullet \cos\gamma$

$a_{22} = \cos\alpha \bullet \cos\gamma - \sin\alpha \bullet \sin\beta \bullet \sin\gamma$

$a_{23} = -\sin\alpha \bullet \cos\beta$

$a_{31} = \sin\alpha \bullet \sin\gamma + \cos\alpha \bullet \sin\beta \bullet \cos\gamma$

$a_{32} = \sin\alpha \bullet \cos\gamma + \cos\alpha \bullet \sin\beta \bullet \sin\gamma$

$a_{33} = \cos\alpha \bullet \cos\beta$

[0026]

In addition, C in the above-described expression (1) is the principal-point distance (focal distance) of a photographing lens of the camera 100, and is the same in the first and second images. That is, the principal-point distance C is the distance between the first camera position (rear-side principal-point position) M_1 and the photographing center c_1 or the distance

between the second camera position (rear-side principal-point position) M_2 and the photographing center c_2.

[0027]

With reference to the flowchart of Fig. 4, a description is given of a survey map preparing routine to produce a survey map on the basis of the first and second images. The survey map preparing routine is executed by a computer into which the first and second images are taken as video data. At this time, the first and second images (Fig. 2(a) and Fig. 2(b)) are displayed on the display screen of a monitor device connected to the computer.

[0028]

First, in Step S101, with respect to an unknown variable in the above-described collinear equation (1), that is, the displacement amount (X_o, Y_o, Z_o) of the second camera position M_2 for the first camera position M_1 and rotation angle (α, β, γ) of the optical axis O_2 for the optical axis O_1, an appropriate value except 0 is inputted into the computer as a default. For example, it is inputted into the computer by operation of, for example, a keyboard.

[0029]

In step S102, two-dimensional coordinates p_{1j} (px_{1j}, py_{1j}) and p_{2j} (px_{2j}, py_{2j}), corresponding to each other, of image points

of the reference point members P_j on the first and second images displayed on the monitor device are inputted into the computer one after another. Also, the two-dimensional coordinates p_{1j} (px_{1j}, py_{1j}) and p_{2j} (px_{2j}, py_{2j}) are inputted by operating, for example, a mouse while pointing to and clicking the image points of the respective reference point members P_j on the first and second images of the monitor device.

[0030]

In step S103, 1 is given to a counter k as a default. Next, in step S104, an optional object point $Q_{k=1}$ (Fig. 1) on the cube 102, which is a subject, is selected, and two-dimensional coordinates q_{1k} (qx_{1k}, qy_{1k}) and q_{2k} (qx_{2k}, qy_{2k}), corresponding to each other, of image points of object points $Q_{k=1}$ on the first and second images displayed on the monitor device are inputted into the computer one after another. Also, the two-dimensional coordinates q_{1k} (qx_{1k}, qy_{1k}) and q_{2k} (qx_{2k}, qy_{2k}) are inputted by operating a mouse while pointing to and clicking the image points of the respective object points $Q_{k=1}$ on the first and second images of the monitor device.

[0031]

The positional relationship between the object point $Q_{k=1}$, the image point of the object point Q on the first and second images, and the first and second camera positions M_1 and M_2 is

similar to the positional relationship between the respective reference point members P_j shown in Fig. 3, the image points p_{ij} on the first and second images thereof, and the first and second camera positions M_1 and M_2, wherein the image points of the object point $Q_{k=1}$ and object point Q_j and the first and second camera positions M_1 and M_2 are located on a straight line. Therefore, the three-dimensional coordinates Q_1 (Q_{X1}, Q_{Y1}, Q_{Z1}) of the object point $Q_{k=1}$ may be obtained by using the expression (1).

[0032]

In step S105, on the basis of input data of the two-dimensional coordinates p_{1j} (px_{1j}, py_{1j}) and p_{2j} (px_{2j}, py_{2j}) and the two-dimensional coordinates q_{1k} (qx_{1k}, qy_{1k}) and q_{2k} (qx_{2k}, qy_{2k}), the above-described collinear equation (1) is solved by a successive approximate analysis. The three-dimensional coordinates P_j (PX_j, PY_j, PZ_j) of the respective reference point members P_j (j=1, 2, and 3), three-dimensional coordinates Q_1 (QX_1, QY_1, QZ_1), unknown variables (X_o, Y_o, Z_o) and (α, β, γ) are approximately obtained.

[0033]

The successive approximate analysis is a method by which a compensation amount of the unknown variable is obtained by the least squares method by giving defaults to the unknown

variables (X_o, Y_o, Z_o) and (α, β, γ) in the above-described collinear equation and securing linearization through Taylor series development around the defaults. By repeating such approximate analysis, the approximate value of further fewer errors can be obtained with respect to the unknown variables.

[0034]

In summary, the three-dimensional coordinates P_j (PX_j, PY_j, PZ_j) of the reference point members P_j (j=1, 2, and 3) are obtained on the basis of the two-dimensional coordinates p_{1j} (px_{1j}, py_{1j}) of the reference point member P_j on the first image, and the two-dimensional coordinates p_{2j} (px_{2j}, py_{2j}) of the reference point member P_j on the second image, and the three-dimensional coordinates Q_1 (QX_1, QY_1, QZ_1) of the object point $Q_{k=1}$ are obtained on the basis of the two-dimensional coordinates q_{1k} (qx_{1k}, qy_{1k}) of the object point $Q_{k=1}$ on the first image and the two-dimensional coordinates q_{2k} (qx_{2k}, qy_{2k}) of the object point $Q_{k=1}$ on the second image, whereby the approximate values concerning the displacements (X_o, Y_o, Z_o) of the second camera position M_2 and the rotation angles (α, β, γ) of the optical axis O_2 can be obtained.

[0035]

In step S106, a compensation magnification m is obtained, which compensates a relative distance on the coordinate values

to a real distance. The calculation uses an already-known distance, for example, the distance between the reference point member P_1 and reference point member P_2. Since the actual distance between the reference point member P_1 and the reference point member P_2 is L (refer to Fig. 1), the following expression can be established between the distance L′ (refer to Fig. 3) between the reference point member P_1 and reference point member P_2 in the three-dimensional orthogonal coordinate system (X, Y, Z) and the actual distance L.

[0036]

$L = L' \times m$ (m: compensation magnification)

[0037]

In step S107, scaling is carried out by using the above-described compensation magnification, whereby a disposition relation may be obtained on the actually measured values between the three-dimensional coordinates P_j (PX_j, PY_j, PZ_j) of the reference point member P_j and the three-dimensional coordinates Q_1 (QX_1, QY_1, QZ_1) of the object point $Q_{k=1}$.

[0038]

In step S108, the three-dimensional orthogonal coordinate system (X, Y, Z) is converted, in terms of coordinates, into the three-dimensional orthogonal coordinate system (X′, Y′, Z′) as shown in Fig. 5. As has been made clear in the same drawing,

the coordinate origin of the three-dimensional orthogonal coordinate system (X′, Y′, Z′) is made coincident with the reference point member P_1, the X′ axis thereof is made coincident with a straight line connecting the reference point members P_1 and P_2, and further the plane X′-Z′ is made coincident with the plane Ps including the reference plane (shown as a hatched area in the drawing). In addition, although the reference point member P_1 is selected as the coordinate origin of the three-dimensional orthogonal coordinate system (X′, Y′, Z′), any optional point on the plane Ps may be made into the coordinate origin of the three-dimensional orthogonal coordinate system (X′, Y′, Z′).

[0039]

In step S109, the plane X′-Z′ is displayed as a survey view on the monitor device. At this time, a projection point of the object point $Q_{k=1}$ is displayed on the plane X′-Z′, that is, the survey view together with the reference point members P_1, P_2 and P_3. Also, the survey view is not limited to the plane X′-Z′, but it may be the plane X′-Y′ or Y′-Z′. Further, it may be a stereo-perspective view on the basis of the three-dimensional orthogonal coordinate system (X′, Y′, Z′).

[0040]

In step S110, it is judged whether or not another object

point is selected with respect to the cube 102. Where another object point is further selected, the process advances to step S111, wherein the value of the counter k is progressed by "1". After that, the process advances to step S104, wherein the two-dimensional coordinates q_{1k} (qx_{1k}, qy_{1k}) and q_{2k} (qx_{2k}, qy_{2k}), corresponding to each other, of images of the object point $Q_{k=2}$ (not illustrated) on the first and second images, which are displayed on the monitor device, are inputted into the computer.

[0041]

In step S105, the above-described collinear equation (1) is solved by a successive approximate analysis on the basis of input data of the two-dimensional coordinates p_{1j} (px_{1j}, py_{1j}) and p_{2j} (px_{2j}, py_{2j}) and two-dimensional coordinates q_{1k} (qx_{1k}, qy_{1k}) and q_{2k} (qx_{2k}, qy_{2k}), whereby the three-dimensional coordinates P_j(PX_j, PY_j, PZ_j) of the respective reference point members P_j (j=1, 2, and 3), the three-dimensional coordinates Q_k (Q_{xk}, Q_{yk}, Q_{zk}) of the object point Q_k, unknown variables (X_o, Y_o, Z_o) and (α, β, γ) are approximately obtained. The approximate values of the unknown variables (X_o, Y_o, Z_o) and (α, β, γ) will become even more approximate than before.

[0042]

In summary, the more the number of object points Q_k is

increased, the closer the approximate values of the unknown variables (X_o, Y_o, Z_o) and (α, β, γ) become to the actual values. In order to obtain reasonable approximate values, at least five points are required, including the reference point members P_1, P_2 and P_3.

[0043]

Fig. 6 is a partially broken view of an embodiment of a stereoscopic photographic surveying target. Fig. 7 is a side elevational view of the stereoscopic photographic surveying target. The target 10 exhibits an L-shaped form, and is provided with two pillar-shaped members 12 and 14. The first pillar-shaped member 12 and second pillar-shaped member 14 are made of a metal material, the interior of which is hollow, and the form of which is square pillar-shaped. And, a non-reflection sheet is attached to the entire circumferential side thereof. The widths L_w of the first and second pillar-shaped members 12 and 14 are roughly equal to each other, and the respective thicknesses L_H thereof are equal to each other.

[0044]

An adhesive agent is adhered to the planes of the non-reflection sheet, which are brought into close contact with the first and second pillar-shaped members 12 and 14 while the opposite planes thereof are black. Further, minute projections

and dents are formed on the surface thereof. Since incident light is absorbed and diffused by the projections and dents, the reflection light volume can be remarkably decreased. Also, non-reflection coating such as, for example, a delustered black coating, etc., may be coated on the surface of the first and second pillar-shaped members 12 and 14 instead of the non-reflection sheet.

[0045]

A rectangular parallelepiped control portion casing 20 is integrally fixed at one end 12a of the first pillar-shaped member 12. The control portion casing 20 is formed of a metal material, and a non-reflection sheet is adhered to the entire circumferential side thereof. At the control portion casing 20, the thickness is the same length L_H as the thickness of the first pillar-shaped member 12, and the width is larger by approximately two times than the width L_W of the first pillar-shaped member 12. The control portion casing 20 is provided so that the side 20b thereof is positioned on the same plane as the side 12b of the first pillar-shaped member 12, the side 20c of the control portion casing 20 protrudes from the side 12c of the first pillar-shaped member 12.

[0046]

One end 14a of the second pillar-shaped member 14 is

rotatably mounted on the side 20c of the control portion casing 20 by means of a hinge 15. The side 14b of the second pillar-shaped member 14 is positioned on the same plane as that of the end 20d at the opposite side of the plane on which the first pillar-shaped member 12 is secured.

[0047]

A stay 16 which is a fixing member is connected at the side of the angle α that is created by the side 14c of the second pillar-shaped member 14 and the side 20c of the control portion casing 20, that is, at the side of an acute angle that is created by the axial centers A and B (shown by a two-dashed chain line in the drawing) of the two pillar-shaped members 12 and 14, whereby the two pillar-shaped members 12 and 14 are fixed to each other. The width and thickness of the stay 16 are smaller than the width L_W and thickness L_H of the first and second pillar-shaped members 12 and 14. In addition, the length of the stay in its lengthwise direction is shorter than the length of the first pillar-shaped member 12 in its lengthwise direction.

[0048]

The stay 16 is provided so as to be inclined with respect to the two pillar-shaped members 12 and 14. At this time, the angle α created by the second pillar-shaped member 14 to the

first pillar-shaped member 12 is 90 degrees. The stay 16 is rotatably secured on the first pillar-shaped member 12 by means of a stay hinge 92, and is detachable from the second pillar-shaped member 14 by a lock hinge 94.

[0049]

Six reference point members 31, 32, 33, 34, 35 and 36 are provided on the same plane on the upper surface of the target 10. The reference point members 31, 32 and 33 are on the upper surface 12e of the first pillar-shaped member 12, reference point member 34 is provided on the upper surface 20e of the control portion casing 20, and reference point members 35 and 36 are provided on the upper surface 14e of the second pillar-shaped member 14. Also, the reference point members P1, P2 and P3 are coincident with the respective reference point members 34, 31 and 36.

[0050]

The respective reference point members 31, 32, 33, 34, 35 and 36 are disks. The diameters thereof are identical to each other, and the diameters are smaller than the dimension of the width L_w of the pillar-shaped members 12 and 14. The reference point members 31, 32, 33 and 34 are provided on a straight line parallel to the A direction of the axial center, and the distances between the respective reference point members 31,

32, 33 and 34 adjacent to each other are equal to each other. Similarly, the reference point members 34, 35 and 36 are provided on a straight line parallel to the B direction of the axial center, and the distances of the respective reference point members 34, 35, and 36 adjacent to each other are equal to each other. Also, the distance from the reference point member 31 to the reference point member 34 is equal to the distance from the reference point member 34 to the reference point member 36.

[0051]

A reference plane for stereoscopic photographic surveying is determined by the reference point members 31, 32, 33, 34, 35 and 36. Simultaneously, the side length of an isosceles triangle in which the reference point members 31, 34 and 36 are the vertices thereof is defined as a reference scale. That is, the distance (the length L shown in Fig. 1) from the reference point member 31 to the reference point member 34, distance from the reference point member 34 to the reference point member 36, or distance from the reference point member 36 to the reference point member 31 is already known, The distance is used as a reference scale in the stereoscopic photographic surveying.

[0052]

Also, the angle α is not limited to 90 degrees. Also, the distance between the reference point members 31 and 34 may not be equal to the distance between the reference point members 34 and 36. The angle α, distance between the reference point members 31 and 34 and distance between the reference point members 34 and 36 may be any figure if it is known in advance. In a case where simplicity in calculation processing is taken in account, it is preferable that the angle α is 90 degrees, and the distance between the reference point members 31 and 34 and distance between the reference point members 34 and 36 are equal to each other.

[0053]

As has been made clear in Fig. 6, since the number of the reference point members differs in the two sides whose lengths are equal to each other in an isosceles triangle, it is possible to easily judge the direction of the target, and where a number of subjects are provided in the same picked-up image, the camera position can be easily conceivable.

[0054]

In addition, since the intermediate points of the first and second pillar-shaped members 12 and 14 are connected to each other and fixed together, the angle α is accurately determined, wherein accuracy of stereoscopic photographic surveying can

be improved.

[0055]

Further, a sheet-like resilient member 19 (Refer to Fig. 10) is provided in clearance between the side 20c of the control portion casing 20 and the end face 14a of the second pillar-shaped member 14, which is produced by attaching a hinge 15, wherein the second pillar-shaped member 14 is prevented from shaking. The resilient member 19 is formed of rubber, sponge or the like, and is adhered to and fixed at the end face 14a of the second pillar-shaped member 14 or at the side face 20c. Also, a spring member may be provided instead of the sheet-like resilient member 19.

[0056]

A reflection sheet is adhered to the reference point members 31, 32, 33, 34, 35 and 36. The surface of the reflection sheet is processed to be smooth and is made white. Thereby, the reflection amount of light can be increased. Further, non-reflection members 41, 42, 43, 44, 45 and 46, which are disk-shaped members to which a non-reflection sheet is adhered, are provided at the peripheries of the respective reference point members 31, 32, 33, 34, 35 and 36. Therefore, it becomes possible to easily identify the reference point members 31, 32, 33, 34, 35 and 36 in a picked-up image, and accuracy of

stereoscopic photographic surveying can be increased.

[0057]

The target 10 is provided with two inclination angle sensors 52 and 54, and the inclination angles regarding the two axis centers A and B orthogonal to each other are measured by the inclination angle sensors 52 and 54. The first inclination sensor 52 is provided between the reference point members 32 and 33 inside the first pillar-shaped member 12. The inclination angle around the axial center A with respect to the horizontal plane is measured by the first inclination angle sensor 52. The second inclination sensor 54 is provided between the reference point members 34 and 35 inside the second pillar-shaped member 14. The inclination angle around the axial center B with respect to the horizontal plane is measured by the second inclination angle sensor 54.

[0058]

The first and second inclination angle sensors 52 and 54 are connected to the control portion casing 20 by cables. Fig. 6 shows only a cable 17 by which the second inclination angle sensor is connected to the control portion casing 20. The inclination angle data around the axial centers A and B, which are measured and obtained by means of the first and second inclination angle sensors 52 and 54, are transferred to the

control portion casing 20.

[0059]

The inclination angle with respect to the horizontal plane of the reference plane is obtained by measuring the inclination angle around the two axes orthogonal to each other. Therefore, in the above-described stereoscopic photographic surveying, it is possible to convert the coordinates from the X'-Z' plane being the reference plane to the horizontal plane, wherein it is possible to display the horizontal plane on a monitor display as a survey map. Also, the coordinate conversion from the X'-Z' plane to the horizontal plane is an already-known method. Herein, detailed description thereof is omitted.

[0060]

The target 10 is provided with three legs 18 on the side opposed to the side where the reference point members 31, 32, 33, 34, 35 and 36 are provided. Fig. 7 shows only two legs 18. The legs 18 are provided so as to correspond to the reference point members 31, 34 and 36. The target 10 is placed with spacing equivalent to the length of the legs 18 secured above the road surface, whereby the target 10 is installed in parallel to the road surface without being influenced by projections and dents on the road surface.

[0061]

Referring to Fig. 8 and Fig. 9, a description is given of the configurations of the reference point member 35 and non-reflection member 45. Fig. 8 is a sectional view of the target 10 on the sectional plane taken along the line VIII-VIII in Fig. 6. Fig. 9 is a plan view showing the plane at the second pillar-shaped member 14 side of the non-reflection member 45. Since other reference point members 31, 32, 33, 34 and 36 and non-reflection members 41, 42, 43, 44 and 46 are similar to the reference point member 35 and non-reflection member 45 in view of the structure thereof, the description is omitted herein.

[0062]

A magnet holding member 62 is provided on the upper surface 14e of the second pillar-shaped member 14, and an annular magnet 64 is accommodated in the interior of the magnet holding member 62. The outer diameter of the magnet holding member 62 has roughly the same dimension as the width L_W of the second pillar-shaped member 14. The magnet 64 is integrally fixed on the second pillar-shaped member 14 by a screw 66 together with the magnet holding member 62. A reflection sheet 68 is adhered on the head portion 67 of the screw member 66. The reference point member 35 is composed of the magnet holding member 62, magnet 64, screw member 66 and reflection sheet 68.

[0063]

The non-reflection member 45 is provided with a disk 72 formed of a material through which electric waves can be transmitted, such as, for example, resin or rubber. Where the material of the disk 72 is rubber, the non-reflection member 45 can be prevented from being damaged due to dropping. A non-reflection sheet 74 is adhered to one side of the disk 72. In the embodiment, the diameter of the non-reflection member 45 is equivalent to seven times the diameter of the reference point member 35, that is, the screw member head portion 67. Also, the thickness of the non-reflection member 45 is slightly smaller than the thickness of the head portion 67 of the screw member 66.

[0064]

A fitting hole 76 having roughly the same diameter as that of the head portion 67 of the screw member 66 is formed at the middle of the non-reflection member 45. On the plane where the non-reflection sheet 74 of the non-reflection member 45 is not provided, an annular iron plate 78 is embedded around the fitting hole 76. The inner diameter of the iron plate 78 is roughly the same as the diameter of the fitting hole 76, and the outer diameter thereof is roughly the same as the outer diameter of the magnet holding member 62.

[0065]

The non-reflection member 45 is detachable from the reference point member 35. When the target 10 is used, the head portion 67 of the screw member 66 is fitted in the fitting hole 76. At this time, the iron plate 78 is adhered to and fixed at the head portion 67 of the screw member 66 or the magnet holding member 62 by a magnetic force of the magnet 64. As has been made clear in Fig. 8, the reflection sheet 68 and non-reflection sheet 74 are roughly on the same plane in a state where the non-reflection member 45 is attached to the reference point member 35. When the target 10 is not used, the non-reflection member 45 is manually removed from the reference point member 35.

[0066]

Thus, by making the non-reflection member 45 detachable from the reference point member 35, portability of the target 10 can be improved. Further, by providing the non-reflection sheet 74 around the reflection sheet 68, the area of the reference point member 35 can be made clear, wherein if the pick-up conditions are worse, for example, in picking up at a site where the periphery is dark due to raining or at night, or at a site where the road surface is easily reflected, it becomes easy to distinguish the reference point member 35 in a picked-up

image.

[0067]

The ratio of the diameter of the reference point member 35 to that of the non-reflection member 45, that is, the size of the area of the reflection sheet 68 and non-reflection sheet 74, is not limited to the size referred to in the present embodiment. The size may be such that the reflection sheet 68 can be sufficiently identified in a picked-up image of the target 10. In addition, the shape of the reference point member 35 and non-reflection member 45 is not limited to a circle.

[0068]

Fig. 10 is an enlarged plan view of the vicinity of the control portion casing 20 in Fig. 6, and the view is partially broken. Fig. 11 is a sectional view taken along the line XI-XI in Fig. 10, which shows a simplified state of the construction of the control portion casing 20.

[0069]

A battery accommodating chamber 83 is provided at the end face 20d side of the control portion casing 20. A battery 87 that is a power source is accommodated in the battery accommodating chamber 83. The battery 87 supplies power to the target 10. The battery accommodating chamber 83 has an opening at the end face 20d side and is enclosed by a lid portion 83a.

A switch 85 is integrally provided on the end face 20d of the control portion casing 20, and the power is turned on and off by manual operations of the switch 85.

[0070]

The upper plane 20e of the control portion casing 20 is provided with an opening 81. The opening 81 is enclosed by a cover 82. The cover 82 is formed of a material through which electric waves can be transmitted, for example, resin. A radio antenna 88 is wound and provided at the edge inside the cover 82. A control substrate 84 and a direction sensor 86 for detecting 86 are provided inside the control portion casing 20. The direction sensor 86 and the first and second inclination angle sensor 52 and 54 are connected to the control substrate 84. The operations of the three sensors 86, 52 and 54 are controlled by the control substrate 84.

[0071]

As has been made clear in Fig. 10, the direction sensor 86 is provided at an intermediate point between the reference point members 33 and 34. That is, where it is assumed that the distance between the reference point members 33 and 34 is L_A, the distance from the center of the direction sensor 86 to the reference point member 33 becomes $(L_A/2)$.

[0072]

The direction sensor 86 is influenced by surrounding magnetic materials, for example, the control portion casing 20, battery 87 or the like. Further, the direction sensor 86 is also influenced by a magnetic force since the non-reflection members 41, 42, 43, 44, 45 and 46 are adhered to and fixed at the reference point members 31, 32, 33, 34, 35 and 36 by the magnetic force. Therefore, the detected direction angle becomes inaccurate, wherein it is necessary to correct the angle. However, as described above, since the direction sensor is provided at an intermediate point between the reference point members 33 and 34, magnetic forces that are generated at the peripheries of the reference point members 33 and 34 are canceled out by each other at the position. Therefore, the direction sensor 86 is hardly influenced by both the magnetic forces.

[0073]

By measuring the direction by the direction sensor 86, it is possible to determine, for example, the Z′ axis of the plane X′-Z′ which is the reference plane, to the north in the above-described stereoscopic photographic surveying. Therefore, for example, where a traffic accident site is spread to a wide area, stereoscopic photographic surveying is carried out with the traffic accident area divided into a plurality

of photographic sections. However, if Z′ axes of a plurality of survey maps obtained for the photographed sites are, respectively, determined to the north, it is possible to easily and accurately link the respective survey maps together.

[0074]

As the power source of the three sensors 86, 52 and 54 is closed by turning on the switch 85, the direction and inclination angle are measured once every fixed period of time in compliance with control pulses outputted from the control board 84, and at the same time, the measured data are outputted to the control board 85. After the direction data outputted from the direction sensor 86 and inclination angle data outputted from the first and second inclination angle sensors 52 and 54 are subjected to prescribed processing such as compensation or the like in the control board 84, the data are wirelessly transmitted to a receiver installed in a digital camera or the like via an antenna 88.

[0075]

The antenna 88 is installed inside the cover 82. Since the cover 82 and the non-reflection members 43 and 44 are formed of a material that is able to transmit electric waves, electric waves transmitted from the antenna 88 are transmitted to the receiver without being interrupted by the cover 82 or the

non-reflection members 43 and 44.

[0076]

Although not illustrated, for example, if a receiver is provided in a digital camera, and the received direction data and inclination angle data are inputted by the digital camera into a computer via a recording medium or the like along with picked up images, processing of the picked-up images can be further quickly carried out by the computer, and a precise survey map can be obtained.

[0077]

Fig. 12 is a plan view showing a state where the target 10 is folded in. Fig. 13 is a plan view of the target 10, showing an intermediate state from an assembled state of the target 10 shown in Fig. 6 to a folded-in state thereof shown in Fig. 12.

[0078]

The target 10 is used in a state where it is assembled to be L-shaped as shown in Fig. 6. However, when it is not used, for example, when it is conveyed, the target 10 is folded in to be I-shaped as shown in Fig. 12. First, the non-reflection members 41, 42, 43, 44, 45 and 46 are removed. Next, the stay 16 is removed from the lock pin 94 of the second pillar-shaped member 14. Thereby, the stay 16 becomes rotatable around the

stay hinge 92 of the first pillar-shaped member 12, and the second pillar-shaped member 14 becomes rotatable around the hinge 15.

[0079]

Further, the stay 16 and the second pillar-shaped member 14 are rotated clockwise, that is, in the direction of the arrow in Fig. 13, and the stay 16 and the second pillar-shaped member 14 is made roughly parallel to the first pillar-shaped member 12. Since the second pillar-shaped member 14 is attached to the control portion casing 20 and the control portion casing 20 protrudes inward of the target 10 from the first pillar-shaped member 12 (that is, leftward in Fig. 12), clearance D is produced between the first pillar-shaped member 12 and the second pillar-shaped member 14. The stay 16 is accommodated in the clearance D, wherein the clearance D that is produced when the target 10 is folded in can be effectively utilized. Also, when being folded in, the lock pin 94 is positioned at the control portion casing 20 side by the stay hinge 92, and does not interfere with the stay hinge 92 and stay 16.

[0080]

However, in a state where the target is only folded in to be I-shaped, the stay 16 and the second pillar-shaped member

14 are rotatable with respect to the first pillar-shaped member 12, the components may unintentionally open when being conveyed, resulting in malfunction or damage. Therefore, the stay 16 and the second pillar-shaped member 14 are fixed on the first pillar-shaped member 12 at the respective ends thereof.

[0081]

The first ball plunger 96 is provided in the vicinity of the reference point member 31 at the side 12c of the first pillar-shaped member 12. On the other hand, a keeper 98 is provided in the vicinity of the reference point member 36 at the side 14c of the second pillar-shaped member 14. By engagement of the first ball plunger with the keeper 98, the first pillar-shaped member 12 and the second pillar-shaped member 14 are fixed together.

[0082]

Fig. 14 is a view showing a fixing mechanism of the first and second pillar-shaped members 12 and 14, which is a sectional view taken along the line XIV-XIV in Fig. 12.

[0083]

The first ball plunger 96 has a recess 104 formed thereon. A projection portion 106 formed on the keeper 98 is engaged in the recess portion 104. The projection portion 106 has a ridge at its tip end, and thickness of the thickest portion

of the ridge portion 106a is slightly smaller than the thickness of the recess portion 104. The thickness of the base end portion 106b of the projection portion 106 is thinner than the ridge portion 106a. In Fig. 14, balls 108 and springs 110 for pressing the balls 108 into the recess portion 104 are, respectively, provided on and under the recess portion 104.

[0084]

If the projection portion 106 of the keeper 98 is pushed in the recess portion 104, the two balls 108 are caused to move apart from the recess portion 104 against a pressing force of the spring 110 by being brought into contact with the ridge portion 106a. If the projection 106 is further pushed into the recess portion 104, the two balls 108 are caused to move to the recess portion 104 side again by a pressing force of the springs 110 and are brought into contact with the base end portion 106b, wherein the projection portion 106 is placed between the two balls 108.

[0085]

By engagement of the keeper 98 with the first ball plunger 96, the second pillar-shaped member 14 is fixed at the first pillar-shaped member 12. Also, where the keeper 98 is removed from the first ball plunger 96, reverse operations of the above-described operations are carried out, that is, the second

pillar-shaped member 14 is pulled from the first pillar-shaped member 12 in the separating direction.

[0086]

Fig. 15 is a view showing a fixing mechanism of the stay 16, and is a sectional view taken along the line XV-XV in Fig. 12. The fixing mechanism of the stay 16 is provided with roughly the same structure as that of the fixing mechanism shown in Fig. 14, and the same components are given the same reference numbers.

[0087]

The second ball plunger 101 is provided at the control portion casing 20 side of the first ball plunger 96 at the side 12c of the first pillar-shaped member 12. The thickness of the stay 16 is smaller than the width of the recess portion 104 formed on the second ball plunger 101, and an accommodation fixing hole 103 is formed on the tip end of the stay 16.

[0088]

As the stay 16 is inserted into the recess portion 104, the two balls 108 are caused to move in a direction separating from the recess portion 104 against a pressing force of the springs 110. As the stay 16 is further inserted, a part of the respective balls 108 is accommodated in both ends of the accommodation fixing hole 103 and engaged with both the ends. That is, the

stay 16 is placed between the two balls 108 by the pressing force of the springs 110 and is fixed on the first pillar-shaped member 12. Also, if the reverse operations are executed, the stay 16 can be removed from the first pillar-shaped member 12.

[0089]

As described above, since the target 10 is provided with a fixing mechanism for fixing the second pillar-shaped member 14 and the stay 16 at the first pillar-shaped member 12 when the target 10 is folded in, the second pillar-shaped member 14 and stay 16 are prevented from unintentionally opening, wherein a malfunction and/or damage which may occur in transportation can be prevented.

[0090]

In order to move the target 10 from a folded-in state shown in Fig. 12 to an assembled state shown in Fig. 6, as described above, the first ball plunger 96 is first disengaged from the keeper 98, and the second ball plunger 101 is disengaged from the stay 16. Next, the second pillar-shaped member 14 is turned by approximately 90 degrees centering around the hinge 15, and the resilient member 19 secured at the end face 14a is brought into contact with the side 20c of the control portion casing 20 (See Fig. 10). Next, the stay 16 is turned centering around

the stay hinge 92, and the end portion is engaged with the locking hinge 94, thereby causing the first and second pillar-shaped members 12 and 14 to be coupled to each other.

[0091]

Fig. 16 is a partially broken plan view of the construction of the vicinity of the stay hinge 92, and is a partially enlarged view of Fig. 6. Fig. 17 is a sectional view taken along the line XVII-XVII in Fig. 16.

[0092]

The stay hinge 92 is provided between the reference point member 33 and the first inclination angle sensor 52 (See Fig. 6) and is fixed at the side 12c of the first pillar-shaped member 12 by a screw 120. A stay accommodation groove portion 122 is formed on the stay hinge 92, and the end portion 16a of the stay 16 is fitted in the stay accommodation groove portion 122. The thickness of the stay accommodation groove portion 122 is slightly larger than the thickness of the stay 16.

[0093]

Fulcrum holes 126 and 128 to pass a fulcrum pin 124 therethrough are formed on the stay hinge 92 and stay 16. The fulcrum pin 124 is pressure-fitted into and fixed in the fulcrum hole 126 of the stay hinge 92 and passes through the fulcrum hole 128 of the stay 16. With the above-described construction,

the stay 16 is made rotatable in the stay accommodation groove portion 122.

[0094]

Fig. 18 is a partially broken plan view showing the construction of the vicinity of the lock hinge 94, and is a partially enlarged view of Fig. 6. Fig. 19 is a sectional view showing a state before the stay 16 is engaged with the lock hinge 94. Fig. 20 is a sectional view showing a state where the stay 16 is engaged with the lock hinge 94, and is a sectional view taken along the line XX-XX of Fig. 18.

[0095]

The lock hinge 94 is provided between the reference point member 35 and the second inclination angle sensor 54 (See Fig. 6), and is fixed at the side 14c of the second pillar-shaped member 14 by the screw 130. A stay accommodation groove portion 132 is formed on the lock hinge 94, and a guide member 134 which is a resilient material such as sheet-like rubber or sponge is adhered to and fixed at the side 132a of the stay accommodation groove portion 132 parallel to the side 14c. Also, the guide member 134 may be composed of rubber or sponge or may be such that a plate member secured in parallel to the side 132a is pressed by a spring in a direction separating from the side 132a. The end portion 16b of the stay 16 is detachable

in the stay accommodation groove portion 132. The thickness of the stay accommodation groove portion 132 is slightly larger than the thickness of the stay 16.

[0096]

A fitting hole 138 through which the lock pin 136 passes is formed downward of the stay accommodation groove portion 132 in Fig. 19. A pin accommodation portion 137 for accommodating the lock pin 136 is formed upward of the stay accommodation groove portion 132, and a fitting hole 140 whose diameter is roughly the same as that of the fitting hole 138 and coaxial therewith is formed in the pin accommodation portion 137. An opening 141 whose diameter is smaller than that of the fitting hole 140 is formed on the upper wall 137a of the pin accommodation portion 137.

[0097]

The lock pin 136 is provided with a head portion 142, an engagement portion 144 having roughly the same diameter as that of the fitting holes 138 and 140, and an intermediate portion 146 that is provided between the head portion 142 and the engagement portion 144 and has roughly the same diameter as that of the opening 141. A spring 148 is provided at the periphery of the intermediate portion 146 in the fitting hole 140. One end of the spring 148 is brought into contact with

the upper wall 137a of the pin accommodation portion 137, and the other end thereof is brought into contact with the upper surface 144a of the engagement portion 144. The spring 148 vertically presses the engagement portion 144, that is, the lock pin 136.

[0098]

The lock pin 136 relatively moves in the vertical direction. If the head portion 142 is manually raised, the spring 148 is compressed in line by elevation of the upper plane 144a and is moved to the position shown in Fig. 19. At this time, the lower end of the engagement portion 144 is positioned upward of the stay accommodation groove portion 132, and the stay 16 is inserted into the stay accommodation groove portion 132.

[0099]

A lock hole 150 having a slightly larger diameter than that of the engagement portion 144 is formed at the end portion 16b of the stay 16. An inclination plane 16c inclined with respect to the side in the lengthwise direction is formed at the corner of the end portion 16b. The inclination plane 16c is caused to slide with respect to the guide member 134 while pressing the guide member 134 when inserting the stay 16 into the stay accommodation groove 132.

[0100]

With the lock pin 136 raised to the position shown in Fig. 19, the stay 16 is caused to slide in the stay accommodation groove portion 132, and the position of the lock hole 150 is made coincident with the fitting holes 138 and 140. If the raised head portion 142 is released after these are made coincident, the lock pin 136 passes through the lock hole 150 by a pressing force of the spring 148 as shown in Fig. 20 and is engaged with the fitting hole 138. At this time, the head portion 142 is stopped by the upper wall 137a of the pin accommodation portion 137, and the lock pin 136 is prevented from falling down.

[0101]

Thus, by causing the lock pin 136 to be fitted in the lock hole 150 and fixing the stay 16 at the second pillar-shaped member 14, the first and second pillar-shaped members 12 and 14 can be integrally coupled to each other by the stay 16.

[0102]

Since the resilient member 19 is provided between the control portion casing 20 and the second pillar-shaped member 14 and the guide member 134 is provided between the stay 16 and the second pillar-shaped member 14, coupling of the first and second pillar-shaped members 12 and 14 by means of the stay 16 is well stabilized, and dimensional accuracy of the target

10 can be improved.

[0103]

After the first and second pillar-shaped members 12 and 14 are coupled to the stay 16, non-reflection members 41, 42, 43, 44, 45 and 46 are attached to the reference point members 31, 32, 33, 34, 35 and 36, respectively, the target 10 is entered into an assembled state shown in Fig. 6 and is used for photographic surveying.

[0104]

In an assembled state, respective components such as the hinge 15, stay hinge 92, lock pin 94, the first and second ball plungers 96 and 101, and keeper 98 are covered up with the non-reflection members 41, 42, 43, 44,45 and 46 so that the components are not photographed in a picked up image. Therefore, it becomes possible to further easily identify the reference point members 31, 32, 33, 34, 35 and 36, wherein accuracy of the stereoscopic photographic surveying can be improved.

[0105]

As described above, in the target 10 according to the embodiment, the reference point members 31, 32, 33, 34, 35 and 36 are further emphasized by providing a reflection sheet on the reference point members 31, 32, 33, 34, 35 and 36, and providing non-reflection members 41, 42, 43, 44, 45 and 46 on

the surrounding thereof. Therefore, identification of the reference point members can be made further easy in a picked-up image, and accuracy of the photographic survey can be improved.

[0106]

Further, since the non-reflection members 41, 42, 43, 44, 45 and 46 are detachable, and the target 10 can be folded in from an L-shaped state to an I-shaped state, maneuverability and portability thereof can be improved. Where the target 10 is L-shaped, precise dimensional accuracy of the target can be obtained by fixing the first and second pillar-shaped members 12 and 14 by the stay 16. Where the target 10 is I-shaped, since the stay 16 and the second pillar-shaped member 14 are fixed on the first pillar-shaped member 12 by means of the first and second ball plungers 96 and 101, portability thereof can be improved.

[0098]

[Effects of the invention]

As described above, according to the invention, a stereoscopic photographic surveying target that is able to easily identify the reference point members on a picked-up image can be obtained.

[Brief description of the drawings]

[Fig. 1] is a perspective view showing the positional

relationship between a stereoscopic photographic surveying target according to an embodiment of the invention, subject and camera;

[Fig. 2] is an exemplary view showing an image picked up by a camera in Fig. 1, wherein Fig. 2(a) is the first image picked up at the first camera position by using the camera shown in Fig. 1, and Fig. 2(b) is the second image picked up at the second camera position shown in Fig. 1;

[Fig. 3] is a view showing, in three-dimensional coordinates, the positional relationship between the reference point members, image point thereof, and the rear side principal point position of the photographing lens of the camera;

[Fig. 4] is a flowchart showing the routine for preparing a survey map of a subject from two images in Fig. 2;

[Fig. 5] is a view showing the three-dimensional coordinates based on a plane including the reference shape;

[Fig. 6] is a plan view showing an embodiment of a stereoscopic photographic surveying target according to the invention;

[Fig. 7] is a side elevational view of a stereoscopic photographic surveying target shown in Fig. 6;

[Fig. 8] is a sectional view of a target, which is taken along the line VIII-VIII in Fig. 6;

[Fig. 9] is a plan view showing a side at the second pillar-shaped member side of a non-reflection member of the target shown in Fig. 6;

[Fig. 10] is a partially broken and enlarged plan view showing the vicinity of a control portion casing of the target shown in Fig. 6,

[Fig. 11] is a sectional view taken along the line XI-XI in Fig. 10, which shows a simplified state of the construction of the control portion casing;

[Fig. 12] is a plan view showing a folded-in state of the target shown in Fig. 6;

[Fig. 13] is a plan view of the target, showing an intermediate state from an assembled state shown in Fig. 6 to a folded-in state shown in Fig. 12;

[Fig. 14] is a view showing a fixing mechanism of the first and second pillar-shaped members of the target shown in Fig. 6, which is a sectional view taken along the XIV-XIV in Fig. 12;

[Fig. 15] is a view showing a fixing mechanism of the stay of the target shown in Fig. 6, which is a sectional view taken along the line XV-XV in Fig. 12;

[Fig. 16] is a partially broken plan view showing the construction of the vicinity of the stay hinge of the target

shown in Fig. 6, which is also a partially enlarged view of Fig. 6;

[Fig. 17] is a sectional view taken along the line XVII-XVII in Fig. 16;

[Fig. 18] is a partially broken plan view showing the construction of the vicinity of the lock hinge of the target shown in Fig. 6, which is also a partially enlarged view of Fig. 6;

[Fig. 19] is a sectional view showing a state before the stay is engaged with the lock hinge of the target shown in Fig. 6; and

[Fig. 20] is a sectional view showing a state where the stay is engaged with the lock hinge of the target shown in Fig. 6, which is a sectional view taken along the line XX-XX in Fig. 18.

[Description of reference numbers]

10 Target

12 First pillar-shaped member

14 Second pillar-shaped member

15 Hinge

16 Stay

20 Control portion casing

31, 32, 33, 34, 35, 36 Reference point members

41, 42, 43, 44, 45, 46 Non-reference members

92 Stay hinge

94 Lock hinge

[Title of the document] Abstract

[Summary]

[Object] To easily identify reference point members of a stereoscopic photographic surveying target and to improve accuracy of stereoscopic photographic surveying.

[Solving means]The control portion casing 20 is integrally fixed on the first pillar-shaped member 12 of the target. The second pillar-shaped member 14 is rotatably attached to the side 20c of the control portion casing 20 by the hinge 15. The first and second pillar-shaped members 12 and 14 are rotatably connected to and fixed at the stay 16. Six reference point members 31, 32, 33, 34, 35 and 36 are provided on the first and second pillar-shaped members 12 and 14 and the control portion casing 20. Non-reflection members 41, 42, 43, 44, 45 and 46 are, respectively, adhered to and fixed at the peripheries of the respective reference point members 31, 32, 33, 34, 35 and 36 with a magnetic force. A reflection sheet is adhered to the respective reference point members 41, 42, 43, 44, 45 and 46, and a non-reflection sheet is adhered to the respective non-reflection members 41, 42, 43, 44, 45 and 46.

[Selective drawing] Fig. 6